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Then follows an account of an elaborate series of investigations of the flow of water through soils, sands, rocks, and other porous media. These are much too extended to be reviewed in detail. They furnish data of prime importance to studies in irrigation, water supply, and various other inquiries that involve the size of grain, the pore-space, and the various elements of resistance to percolation. The industrial as well as the scientific value of these determinations, with which are collated those of others, is obvious.

The value of the experimental study of Professor King is greatly enhanced by the theoretical investigation of the motions of ground water by Professor Slichter. The treatment is mathematical and can be read only by those who are familiar with its elegant language. The excellent illustrations, however, translate some of the more vital parts into the vernacular. Those which relate to the interferences of flows into artesian and other wells are especially instructive.

T. C. C.

Les Lacs Francais. Par ANDRÉ DELEBECQUE. Ouvrage couronné par l'Academie des Sciences. 436 pp., 22 plates, and 153 figures in the text. Accompanied by an atlas of 10 maps. Paris: 1898.

This elaborate work is divided into ten chapters, and a brief outline is here given of the substance of each :

I. *Distribution.*—Most of the lakes of France are in the mountains, the Alps, the Juras, the Vosges, and the Pyrennees; but there are some in the central plateau, some along the coasts, and still others which do not admit of ready classification. The total number of lakes given is between 460 and 470, but many of them are so small that in our own country they would be called ponds.

II. *Depth.*—The second chapter has to do with the depth of the lakes, and the chartings of the soundings.

III. *Description.*—The third chapter is a description of the principal lakes, the description taking account of the depth, the area, the position, etc. Contour maps of the basins of more than forty lakes are given on the plates. Of lakes more than 25 meters deep, there are thirteen in the Alps, eleven in the Juras, two in the Vosges, eight in the central plateau, twelve in the Pyrennees, and one on the coast of the Mediterranean, forty-seven in all. Of lakes more than 1000 hectares (approximately four square miles) in area, there are in the Alps two, in the Juras one, along the Atlantic coast four, and along the Mediterranean coast two. Even of lakes more than 250 hectares in area (approximately one square mile) there are but thirteen. It will be seen therefore that most of the lakes are very small. The tables show that the depth of many of them is great in comparison with their area.

IV. *Topography.*—The fourth chapter deals with the character of the topography and relief of the lake bottoms. Few of the lakes have great depth. Lake Geneva has a maximum depth of $\frac{1}{237}$ of its length and $\frac{1}{54}$ of its width, but these ratios are exceeded by many of the smaller lakes. The deepest lakes in proportion to their area are in the Pyrennees. Here Lac Bleu has a depth of 120 meters with an area of but 47 hectares. In the lake bottoms are recognized (*a*) the marginal plains, partly wave cut and partly wave built; (*b*) the tallus slopes (a talus slope of 87° runs down to a depth of 42 meters in one case, and a slope of 63° to a depth of 100 meters in another), and (*c*) the bottom flats. In the large lakes the sensible flat (or flats) at the bottom is some considerable fraction of the total area. In Lake Geneva the bottom flat of an area one twelfth of the total area of the lake has a relief of less than five meters. These flat bottoms are naturally more distinct in the large lakes than in the small ones. Certain more or less accidental features are recognized in the topography of the lake bottoms. Here are classed deltas, submerged valleys, ravines, hills and islands and funnels. The latter are rare, and represent either places where springs enter the lake, or where sub-surface drainage escapes. Two or three remarkable instances are cited, especially in Lac d'Annecy.

V. *Nature of the bottoms.*—The nature of the bottom is the topic of the fifth chapter. The bottom consists in part of alluvium, and in part of the rock in which the basin occurs. The alluvial material is found to vary both microscopically and chemically with the nature of the rock of the basin. Numerous tables of results are given. The following conclusions are reached: (*a*) The material at the bottom of the lake varies with the rock. In limestone basins calcareous matter dominates, while in basins in siliceous rocks, quartz is most abundant. (*b*) The mean composition of the sediment in the lake is not the same as the mean composition of the rocks in the basin. For example, the sulphates are essentially absent in certain lakes whose affluents flow over gypsum, or whose shores are partly of gypsum. On the other hand, sulphuric acid is found in small quantity in lakes where there is no gypsum adjacent. Again, calcium is abundant in basalt, but not in the sediment in lakes in basaltic regions. Alkalis are plentiful in granitic rock, but only sparingly present in the lakes in granitic basins. The alkalis and alkaline earths are carried off in solution, chiefly as carbonates, while the silica stays behind and is thus concentrated. (*c*) The composition of the sediment varies in different parts of the same lake.

Sediment is absent in the bottom of the lakes where the slope is too steep for it to rest, in general where the slope is over 45°, and where local conditions have prevented deposition, as where springs enter or where drainage flows out. Sediment is also absent where currents have been effective at the bottom.

VI. *Supply and loss.*—A chapter is devoted to the supply and loss of water, and to the variations in the levels of the lakes. An interesting section is given to the average length of time which water stays in lakes. This is determined from the volume of the lake, and the rate of outflow. Thus in Lake Geneva, it is found that the average stay of water in the lake is eleven years and seventy-three days; in lake d'Annecy three years and one hundred and thirteen days; in Lake Chaillexon five days. Many other calculations are given, all of which tend to show that the duration of the stay of water in lakes is extremely variable. Lakes with surface outlets are found to change their levels but slightly. Data on this point seem somewhat imperfect, but the maximum known fluctuation in the case of lakes having surface outlets is three meters. In lakes having sub-surface outlets, fluctuations of level are far greater. They appear also to be greater for small lakes than for large ones. Thus the level of Lake Chaillexon between August 19, 1892 and December 31, 1895, fluctuated sixteen meters.

VII. *Temperature.*—The tables of temperature given show that the water at the bottoms of the deep lakes varies very little, and that it is near the temperature of greatest density all the time. The tables show that in most lakes there is a well-defined zone which separates the warm (during most of the year) water above from the cold water below, the transition being usually rather abrupt. This zone of transition is rarely more than twenty meters below the surface, and sometimes not more than ten. The causes determining temperature are considered. Aside from (*a*) climate, the effect of which is obvious, (*b*) the average depth, (*c*) the form and orientation of the lakes, and (*d*) the sources of supply, influence their temperature. The form and orientation of the lakes is of importance in connection with the winds. Lakes which are oriented so as to allow winds to exert their most important influence in the generation of currents, have their temperature equalized in the vertical sense, through the return currents. Circulation is thus shown to be of more importance than conduction in equalizing the temperature between top and bottom. The rôle of affluents in determining lake temperatures is very variable. It depends on the size of the lake, the average stay of the water in the lake, and the nature of the affluents themselves. Following Forel, the author emphasizes the paradoxical fact that the waters of the glacial Rhone raise the temperature of Lake Geneva, the temperature of the river being notably above that of the lower part of the lake at all times, while the large amount of sediment in the river water so increases its specific gravity as to cause it to descend much below the zone of lacustrine temperature corresponding to its own. Sub-surface affluents exert an important influence in their immediate surroundings, or, if the lake be very small, on the whole volume of water. The temperatures of these affluents being essentially constant, the temperature of the lake is differently affected by them in different seasons. Lakes are classified by the author, following Forel, on the thermal basis, as *tropical*, *temperate*, and *polar*. The tropical lakes are those whose surface waters do not reach 4° C.; the temperate lakes are those the surface waters of which are sometimes below and sometimes above 4°; while the polar lakes are those whose surface waters never rise above 4°. Of the first class the larger part of Lake Geneva, and certain salt lakes near the shore are the only representatives. To the second class most of the lakes of France belong, but there are a few representatives of the third class in the Pyrenees, and in certain other high altitudes.

Chapter VIII deals with the *transparency*, *color*, etc., of the lakes. The lakes are partly blue (few), partly green (the larger number), and partly yellow (a large number.) The color is found to be influenced by (*a*) the dissolved organic substances, such as humic and ulmic acids; (*b*) the presence of vegetable and animal organisms in the water; and (*c*) the inorganic sediment. The transparency is found to vary within a given lake with the season, and with the position of the station. It is greater in winter than in summer, and increases with increasing distance from the debouchures of streams. The water of the blue lakes is most transparent, that of the green less, and that of the yellow least.

IX. *Matter dissolved in the water of the lakes.*—With the exception of the salt lakes, none of the lacustrine waters contain so much as one gram of solid matter per liter, and in five cases only does it exceed .3 gram per liter. There are notable variations in the amount and kind of dissolved matter depending upon the character of the basin, and there are notable variations in the same lake in different seasons, and in different parts during the same season. In the summer the warm waters in the upper portions of the lakes are poorer than the colder waters below, in some of the dissolved substances, especially $Ca\,CO_3$ and SiO_2, while in winter the solutions are nearly uniform throughout. In general, the lake waters have less solid matter in solution than the inflowing rivers, showing that dissolved matter is lost in the lakes. This loss is attributed largely to precipitation, and it seems to be implied that calcareous tufa is of very common occurrence. This would hardly hold for the greater number of the lakes in the United States. With reference to dissolved gases, the conclusion is reached that the amount of these gases, chiefly CO_2, O, and N, are independent of pressure, but that they increase with depth on account of the lower temperature. The amount of carbonic acid gas dissolved far exceeds that of oxygen and nitrogen together, whether measured by weight or by volume. Little account is taken of other gases.

X. *Geological position and origin.*—The classification of lakes in general is briefly outlined, and the lakes of France fitted to the classification. Two primary classes of lake basins are recognized: (1) Those produced by barriers of one sort and another, and (2) rock basins. Of the barrier basins there are many types, most of which are represented in France. The barriers are of various types as follows: (1) *Landslides.* Lake basins produced in this way are found in the Alps, the Juras and the Pyrenees, but are not numerous. (2) *Ice.* No existing lake in France owes its existence to an ice barrier. One extinct lake is so classed. (3) *Moraines.* The moraine of an existing glacier is the barrier which gives origin to a single lake,—Lac Long in the Alps. Lakes which owe their origin to moraines of extinct glaciers are numerous and of several classes. Here belong (*a*) lakes in valleys which were occupied by glaciers, the moraine forming a dam at the lower end of the lake. Of this class there are several representatives in the Alps, the Juras, and the Vosges Mountains, one in the central plateau, and one in the Pyrenees; (*b*) lakes which result from the blocking of a lateral valley by the moraine of the glacier which occupied the main valley. Of this there are representatives in the Alps, the Juras, and the Pyrenees; (*c*) lakes which lie in basins occasioned by the irregular deposition of drift. But two lakes fall into this category, one in the Alps, about which there is some question, and one in the Juras. In our own country lakes of this class are more numerous than any other. (4) *Lava.* Several lakes, the basins of which are formed by lava dams, are found in the central plateau. (5) *Volcanoes.* Two lakes in the central plateau owe their origin to growth of volcanoes in the bottoms of valleys. (6) *Craters.* Several lakes in the central plateau occupy craters. (It is not altogether clear why crater lakes should be classified among the lakes produced by barriers). (7) *River alluvium.* Lakes formed along rivers by the deposition of alluvium are represented by a few lakes in the Alps, Juras and along the Mediterranean coast. (8) *Bars.* A few lakes on the coast owe their origin to the construction of bars which shut off a portion of the sea water, leaving inland basins. (9) *Dunes.* There are several lake basins completed by dune barriers along the Atlantic coast.

Of the lakes which occupy basins in the rock, one group owes its origin to internal forces. In this category belong the basins produced (1) by violent volcanic disturbances, such as explosions, of which there are several examples in the central plateau; and (2) lakes produced by secular movements. To this class belong several lakes in the Alps (Geneva and d'Annecy), and in the Juras, though concerning the origin of the latter there seems to be some question. Of the lake basins originating through the action of external forces, there are (*a*) those resulting from solution effected by underground waters, represented in the Alps and along the Atlantic coast, in the Juras, along the Mediterranean, and in one or two other places; (*b*) lakes due to erosion of rock along fissures, as where a fissure crosses a watercourse; and (*c*) basins due to excessive local erosion by the ice, represented in the Alps by several examples, in the Juras by one possible example, in the Vosges by one, in the central plateau by several, and in the Pyrenees by a considerable number. Here belongs Lac Bleu, of extraordinary depth. It is probable that in the production of many of the lake basins more than one factor has been involved.

XI. *The life history of lakes.*—After a consideration of the various causes which may bring the life of a lake to an end, the history of a few of the principal lakes of France is sketched. The level of Lake Geneva has been lowered about 30 meters since the glacial time. It had one stationary level between the highest and the present levels, when the water stood 10 meters higher than now. The other lakes especially considered are Bourget, which has also been lowered in postglacial time, and d'Annecy, which was formerly 15 meters lower than now. The rise was occasioned by alluvial deposits in the valley of the Fier, to which the outlet of the lake flows. These deposits have dammed the exit. The history of Lacs de Saint Point and Remoray —in the Juras—is also outlined, the interesting point being that they were formerly one lake, now divided into two by the growth of a delta completely across the narrow basin. The growth of deltas seems to have played a large part in the history of many of the mountain lakes. This is the natural course of events where torrential streams debouche into the standing water. Many other lakes appear to have had their areas greatly diminished by similar processes. Reference is also made to certain extinct lakes, and the criteria by which their former existence is recognized are briefly given.

The figures in the text of the volume are largely half tones, which unfortunately, cannot be said to be of more than medium grade. It could have been wished also that the few maps of the text which show features other than the topography of the lake bottoms, could have been clearer. On the whole they have so much ink, that it is difficult to find the points sought. It is always a serious problem to make a map clear, and at the same time get a great deal on it, and in this case the difficulty has not been overcome.

R. D. S.

On the Building and Ornamental Stones of Wisconsin. By. E. R. BUCKLEY, Ph.D., Madison, Wis., 1898. Pp. xxvi + 544. Bull. No. 4. Economic Series No. 2 of the Wisconsin Geological and Natural History Survey.

Dr. Buckley's report is one of the most compendious volumes on the subject of building stones published in recent years. Of the three parts into which the subject-matter is divided the first treats of the demands, uses, and properties of building and ornamental stones in general. This is a valuable though brief discussion of the subject.